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PLIOCENE NON-MARINE MOLLUSKS FROM
CONTRA COSTA COUNTY, CALIFORNIA

By

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INTRODUCTION

Probably no area in California has been mapped as often as the Berkeley Hills, along the east side of San Francisco Bay, California. For well over half a century students in the Departments of Geology and Paleontology at the University of California have acquired the fundamentals of field geology by studying the geology of the Berkeley Hills. Fossil mollusks have occasionally been noted by the numerous field parties, yet no studies of this material have been published since J. G. Cooper's description of three species in 1894. The mollusks have mostly been found in the area of Siesta Valley, about 4 miles east of the Berkeley campus of the University of California. This report presents the results of a study of the material currently available at Berkeley.

I am indebted to Robert Kaar of San Francisco City College and his students, who collected many of the specimens and were first to bring them to my attention. Thanks also are due to professors J. W. Durham, Department of Paleontology, University of California, and Edwin C. Allison, San Diego State College, for critical reading of this paper. Special thanks to my wife, Jean, and to Howard Schorn and Howard Hutchison, graduate students at the University of California, for their aid and suggestions.

PREVIOUS WORK

SIESTA FORMATION.

J. G. Cooper (1894a, pp. 54, 55) described *Lymnaea contracosta*, *Planorbis pabloanus* and *Anodonta nuttalliana lignitica* from a lignite bed along the west branch of San Pablo Creek. Cooper considered the sedimentary strata to be

deposits of a Pliocene lake. Later Cooper (1894b, p. 169) listed the same three species and called the sedimentary strata the Contra Costa Lake Beds. The Contra Costa Lake Beds are now referred to the Siesta formation.

The Siesta formation was named by Lawson and Palache (1902, p. 384) as the Siestan formation, and included in the upper Berkeleyan. Lawson (1914) abandoned the name Siestan in favor of Siesta, and considered it the middle formation of the Berkeley group.

The literature contains no reference to the repository of Cooper's types of the above species. An intensive search of the invertebrate collection of the Museum of Paleontology, Berkeley, which contains many of Cooper's types, failed to uncover them. Possibly the types were deposited in the collections of the California Academy of Sciences (their collections contained many of Cooper's types of Recent mollusks, deposited there before the earthquake and fire of 1906). Most of their fossil invertebrates were destroyed in the 1906 disaster, and if the types were deposited prior to that time they were not among the few recovered.¹ Therefore, the types of these species are presumed lost or destroyed.

A list by Merriam (1896, p. 363) includes the gastropods *Ancylus* species and *Helix* species, and the ostracod *Cypris* species in addition to the three species listed by Cooper. Lawson and Palache (1902) listed, in addition to the above taxa, the pelecypod *Pisidium* species.

MULHOLLAND BEDS.

East of the Siesta formation, in nearby Orinda, exposures of lacustrine strata contain both molluscan and mammalian fossils. In Rheem Valley and near Saint Mary's College, farther to the southeast, there are extensive exposures of lacustrine strata which are referred to the same litho-stratigraphic unit as those at Orinda. All of these beds have been referred to as the "Mulholland Formation" (Ham, 1952, p. 6). Originally these beds were mapped as part of the Orinda formation by Lawson (1915).

The name Mulholland was first associated with these beds, although not in a litho-stratigraphic sense, by Stirton (1939), who designated a mammalian fauna from "near Saint Mary's College" as the Mulholland fauna. Subsequently Axelrod (1944, p. 104), in discussing the Mulholland flora, referred to a "lithologic similarity between the Tassajara formation and the Mulholland region." Later, in the same paper, he referred to a "probable correlation of the Mulholland with the Tassejaro,"² thus imparting a litho-stratigraphic sense to the Mulholland. His purpose, however, clearly was not to assign formational rank to the Mulholland, as he stated that the criteria for defining the unit "is not yet assembled."

¹ It is reported that F. M. Anderson sifted through the ashes of the old Academy of Sciences building, recovering some of the invertebrate types, notably of the larger ammonites.

² A misspelling of Tassajara.

The name Mulholland formation was proposed by Savage, Ogle, and Creely, in a paper read before the Cordilleran section of the Geological Society of America meeting in Los Angeles in 1951. The published abstract of this paper (Savage *et al.*, 1951, p. 1151) does not contain the words Mulholland formation, stating only that "Unit (5) was originally mapped as Orinda, but a separate formation name is warranted . . ." Their unit (5) is composed of "Middle Pliocene flood plain and lacustrine sediments with minor tuffs." The paper was never published. Later Ham (1952) referred to the "Mulholland Formation" (his quotation marks) and cited the unpublished paper of Savage *et al.*, as his authority. The name Mulholland formation (without quotation marks) was catalogued by Wilson, Sando, and Kopf (1957, p. 249), who cited Ham as the author.

No published type section nor map of a Mulholland formation exists. Therefore, in referring to that unit heretofore called Mulholland formation or "Mulholland Formation," I shall use the terminology Mulholland beds.

GEOLOGY

The lacustrine strata of the Siesta formation disconformably overlies the Grizzly Peak Volcanic member of the Moraga formation, and are conformably overlain by the Bald Peak formation (basalts and lacustrine strata). A disconformity between the Grizzly Peak Volcanic member and the Siesta formation is inferred by Lawson and Palache (1902) on the basis of a "laterized zone" which they interpret to indicate an erosional period of some duration. The lacustrine shales and claystones assigned to the Siesta formation occupy the trough of a southeast plunging asymmetric syncline, the axis of which lies in, and parallel to, Siesta Valley. The western limb of the syncline is steeply dipping in its northern portion and is overturned in its southern portion.

The Siesta formation is composed of a series of poorly sorted sandstones, shales, clays, mudstones, limestones, and thin lignitic layers considered to be largely of lacustrine origin. Near the head of Siesta Valley the beds are approximately 300 feet thick, but thicken to approximately 1400 feet in the southeastern portion. Preservation of the fossils is generally poor.

The basal Mulholland beds are principally mudstones, with occasional thinly bedded shales. Preservation of the fossils is poor, but generally better than in the Siesta. The upper part of the Mulholland section is distinctly bedded and, in some places, is composed of medium to coarse-grained, cross-bedded sandstones. At locality B-7270 the section is capped by a pebble conglomerate.

AGE

Age determination of the Siesta formation is currently possible by two methods: the Potassium-Argon method and determination on the basis of the

included fossil mammals. Evernden *et al.* (1964, pp. 162, 163) assign the Siesta formation to the Clarendonian North American land mammal age with a radiometric age of 9.9×10^6 years. The sample used in deriving this data was obtained from a "crystal vitric tuff in basal beds of the Siesta Formation." The presence of the horse *Hipparion*, compare *H. mohavense*, and the beaver *Eucastor leconti*, support a late Clarendonian assignment.

Associated mammals from the Mulholland beds (UCMP³ localities B-7269, B-7270) indicate a probable Hemphillian North American land mammal age. Savage *et al.* (1951) list the rhinoceros *Teleoceras*, compare *T. fossiger*, the beaver *Dipoides* species and the horse *Pliohippus* compare *P. spectans* from the Mulholland beds, and state that these animals existed only during Hemphillian time.

RELATED FAUNAS

A brackish and fresh-water molluscan fauna from the Petaluma formation was described by Hanna (1923). I found several of the fresh-water taxa described by Hanna to be the same as the species from the Siesta formation and Mulholland beds. These are listed in Table 1.

The age of the Petaluma formation was originally considered to be upper Miocene by Dickerson (1922) who believed it to be a non-marine facies of the marine San Pablo. However, Stirton (1952) considers the Petaluma to be no older than middle Pliocene (Hemphillian) on the basis of the presence of *Neohipparion gidleyi*, a highly progressive horse of the *N. eurystyle* group. Axelrod (1944) holds a similar view based on the Sonoma flora, which he considers to be upper Pliocene. On the basis of marine mollusks from the Merced in the Santa Rosa and Petaluma regions Durham (*in* Stirton, 1952, p. 2014) reaches a similar conclusion.

PALEOECOLOGY

SIESTA FORMATION.

The lithologic and paleontologic characteristics of the Siesta formation indicate cyclic lacustrine sedimentation. Coal seams and lignitic shales are normally formed during the last stages (marsh or bog phase) of lake development, when water is shallow and the lake is occupied by vegetation. The presence of lignitic shales and coal seams at several horizons, interspersed with sandstones, mudstones, and clays, are evidence for the periodic rejuvenation of the lake. It is probable that orogenic activity was at least in part responsible for this periodic rejuvenation. The poorly sorted sediments, principally fine-grained sand and clay-sized clastic particles, indicates deposition in a low energy environment.

³ UCMP = University of California Museum of Paleontology.

TABLE 1. Check list of molluscan species and comparison with *Petaluma* fauna.

	<i>Siesta</i> formation	<i>Mulholland</i> beds (lower)	<i>Mulholland</i> beds (upper)	<i>Petaluma</i> formation
PELECYPODA				
<i>Sphaerium cynodon</i> Hanna	X	X		X
<i>Sphaerium</i> species		X	X	
<i>Anodonta nuttalliana lignitica</i> Cooper	X	X	X	
<i>Pisidium curvatum</i> Hanna				X
GASTROPODA				
<i>Deroceras pachyostrakon</i> (Taylor)			X	
<i>Gyraulus pabloanus</i> (Cooper)	X	X		
<i>Goniobasis</i> species (undetermined)	X			
<i>Helminthoglypta</i> species (undetermined)			X	
<i>Lymnaea filocosta</i> Hanna	X		X	X
<i>Lymnaea petaluma</i> Hanna	X	X		X
<i>Lymnaea</i> compare <i>L. kerri</i> Hanna			X	X
<i>Lymnaea</i> (?) <i>limatula</i> Hanna				X
* <i>Lymnaea contracosta</i> (?) Cooper	X			X
<i>Physa</i> species ?				X
<i>Planorbis pleiopleurus</i> Hanna				X
<i>Planorbis plenus</i> Hanna				X

* Hanna (1923, p. 40) lists *L. contracosta* (?) on the basis of specimens "too badly crushed for positive identification." I have listed this species as occurring in the Siesta formation on the basis of Cooper's report.

The molluscan fauna of the Siesta is not large, including only aquatic genera tolerant of wide changes in environmental conditions. A hydrogen ion concentration of less than pH 7.0 must have existed at times in the lake to allow for the deposition of coal and lignite, which require an acid water environment. It is probable that the lake was, at least at the time of coal deposition, in a dystrophic state. None of the molluscan genera represented in the Siesta is restricted to alkaline water in present day habitats.

All of the gastropods except one are pulmonates whose living representatives may be found in temporary ponds or permanent bodies of water. The sole non-pulmonate is *Goniobasis*, a pleurocerid genus that is generally tolerant of adverse conditions as long as the basic requirement of a permanent body of water is met. It is known only from one locality, however, which may indicate that it was not able to exist through the succeeding dryer marsh stage. The two pelecypod genera, as well as the pulmonate gastropods, have the ability to burrow into the substrate and aestivate during periods of drought.

MULHOLLAND BEDS.

The rocks represented in the Mulholland beds are very similar to those of the Siesta formation, being principally composed of fine-grained sand-size to clay-size clastics. The fauna of the lower portion of the Mulholland beds is similar to the Siesta molluscan fauna. I have found no terrestrial mollusks

from either the Siesta or the lower Mulholland, but two terrestrial genera, *Deroceras* and *Helminthoglypta*, are well represented in the upper Mulholland beds. The presence of the terrestrial forms in locally abundant concentrations, coupled with a reduced aquatic fauna in the upper beds, indicates a possible change from a lacustrine to a riparian environment. This view is supported by localized cross-bedding in the upper beds.

Although there is no dramatic faunal change from the Siesta, the fossil mollusks of the Mulholland beds are generally larger and thicker shelled. Also, no coal or lignite seams (typical of the Siesta) occur in the Mulholland. It may be inferred, therefore, that the trophic state of the lacustrine environment changed from a somewhat dystrophic state to a more eutrophic one. The geologic structure of the area supplies evidence of tectonic activity during deposition of the lacustrine sediments. Attendant uplift is the most probable cause of the freshening of the lake waters. The final result of this tectonic activity seems to have been the replacement of a lacustrine by a riparian regime.

LOCALITY REGISTER

All localities are in Contra Costa County, California, within the Oakland east quadrangle, 7½' series, 1949 edition, the Briones Valley quadrangle, 7½' series, 1959 edition, and the Las Trampas Ridge quadrangle, 7½' series, 1959 edition. All locality numbers refer to University of California Museum of Paleontology (UCMP) invertebrate collections.

B-7266. State grid coordinates 1,504,900–507,600, T.1 N., R.3 W., Briones Valley quadrangle. One thousand six hundred feet S. 30° E. from summit of Vollmer Peak (B.M. 1905), exposed in ditch across the road from the Grizzly stables on Lomas Cantada road, and in saddle between low hill and Vollmer Peak. Gray to white limestone bed approximately 10 feet thick, striking N. 60° W. Siesta formation.

B-7267. N.W.¼ of S.E.¼ of section 4, T.1 S., R.3 W., Oakland east quadrangle. East limb of syncline, just north of California State Highway 24 in road cut terrace, about 50 feet above highway. Moderately well bedded, friable, fine grained sandstone and shale. Siesta formation.

B-7268. N.E.¼ of S.W.¼ of section 4, T.1 S., R.3 W., Oakland east quadrangle. West limb of syncline, just north of old route of California State Highway 24, adjacent to unpaved road that goes north up Siesta Valley. This locality has been largely destroyed by the construction of the approach to the new bore of the Caldecot tunnel. Gray, poorly bedded to massive claystone. Siesta formation.

B-7269. State grid coordinates 1,513,600–508,000, T.1 N., R.3 W., Briones Valley quadrangle. Four-tenths mile N.W. of Orinda cross-roads on San Pablo Dam road. Face of excavation behind annex to Orinda Union School. Calcareous

mudstone, brown to gray in color, striking N. 65° W., dipping 50° S.E. Equals UCMP vertebrate locality V-5017. Lower Mulholland beds.

B-7270. S.W.¼ of N.E.¼ of section 7, T.1 S., R.2 W., Las Trampas Ridge quadrangle. Three hundred yards southeast of junction of Moraga Road with Rheem Blvd. Quarry on southwest facing slope, in blue to gray ferruginous sandy clays and shales, stratigraphically below prominent pebble conglomerate. Equals UCMP vertebrate locality V-3611. Upper Mulholland beds.

SYSTEMATIC PALEONTOLOGY

PELECYPODA

UNIONIDAE

ANODONTINAE

Anodonta Lamarck, 1799

Type *Mytillus cygneus* Linnaeus

Anodonta nuttalliana lignitica Cooper, 1894.

(Figure 1.)

Anodonta nuttalliana lignitica COOPER, 1894, p. 55, fig. 58.

DIAGNOSIS. A species of *Anodonta* with umbones $\frac{1}{3}$ distant from anterior end, posterior margin slightly concave above midline to meet straight hinge line $\frac{1}{3}$ distant from posterior end; length to height ratio of 2:1.

DISCUSSION. Because of their poor preservation, it is not possible to definitely assign the present specimens from the Siesta formation to *Anodonta nuttalliana lignitica*, although they most likely belong to Cooper's subspecies. Specimens from the Mulholland beds are better preserved, and so closely agree with Cooper's description that they may be assigned to this subspecies with a high degree of certainty. The only apparent difference being that the growth lines, where visible, generally are more sharply curved than those shown in Cooper's illustration.

OCCURRENCE. In the limey sandstone, shales and clays of the Siesta formation; UCMP localities B-7267, B-7268. Abundantly represented in the basal Mulholland beds, UCMP locality B-7269; rare in upper Mulholland beds, UCMP locality B-7270.

SPHAERIIDAE

Sphaerium Scopoli, 1777

Type *Tellina cornea* Linnaeus

Sphaerium cynodon Hanna, 1923.

Sphaerium cynodon HANNA, 1923, pp. 35, 36, pl. 1, figs. 4, 5, 6.

DIAGNOSIS. A large and robust species of *Sphaerium* with elevated umbones, right valve with equally prominent teeth, left valve with two blade-like laterals, the anterior being higher and less elongate than the posterior.

DISCUSSION. The present specimens are somewhat smaller (10.6 mm. ×

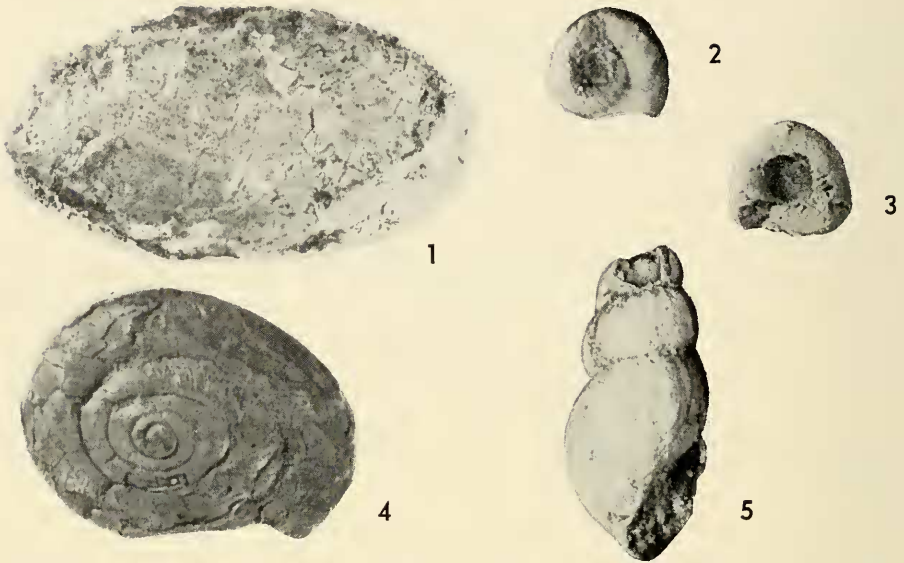


FIGURE 1. *Anodonta nuttalliana lignitica* Cooper. LENGTH 24.8 mm. UCMP no. 12174.
 FIGURES 2, 3. *Gyraulus pabloanus* (Cooper). DIAMETER 3.7 mm. UCMP no. 32486.
 FIGURE 4. *Helminthoglypta* species. DIAMETER 15.0 mm. UCMP no. 32992.
 FIGURE 5. *Goniobasis* species. HEIGHT 10.0 mm. UCMP no. 32993.

8.7 mm.) than those described by Hanna, but the proportions are the same and the characters largely agree with his description and figures. The umbones appear slightly less elevated than in Hanna's specimens, but this may be due to moderate compression of the shell.

OCURRENCE. In claystones near base of Siesta formation, UCMP localities B-7267, B-7268, and less commonly in the limestone bed, UCMP locality B-7266. Abundant at UCMP locality B-7269.

GASTROPODA

LYMNAEIDAE

Lymnaea Lamarck, 1799

Type *Helix stagnalis* Linnaeus

Lymnaea petaluma Hanna, 1923.

Lymnaea petaluma HANNA, 1923, pp. 37, 38, pl. 2, figs. 3, 7.

DIAGNOSIS. A species of *Lymnaea* with a high, pointed spire of four gently convex whorls bearing irregular growth ridges and fine growth striae with no trace of spiral sculpture.

DISCUSSION. The size and proportions of the present specimens agree with the measurements given by Hanna in the original description. In examining the

present specimens it was noted that in at least one instance (a very large individual) the outer lip was slightly flared, in contradiction to the original description. After comparison of this individual with the type specimen and with other specimens from the same and nearby localities, it is my opinion that the flared outer lip is a gerontic character. None of the other specimens show this character.

The present specimens assigned to this species show little similarity to the figure and description of *Lymnaea contracosta* Cooper, 1894. As Cooper's figure is stated to be drawn from crushed specimens, the possibility that the present specimens might represent *L. contracosta* was considered. However, the body whorl is much too inflated and the spire proportionally too high to be referable to *L. contracosta*. Cooper cites the "lignitic laminae" as the locality for *L. contracosta*. There are, however, several horizons of lignitic shales and coal beds in the Siesta. Almost all of those investigated contained *L. petaluma*, but none contained *L. contracosta*. From Cooper's rather vague locality description, it appears that his "lignitic laminae" occurs fairly high in the sequence, and in the upper reaches of Siesta Valley. As yet I have been unable to find the locality. It is possible that *L. contracosta* occurs only in the upper part of the formation, or is perhaps restricted to a particular "lignitic laminae."

OCCURRENCE. In shales, mudstones, sandstones, and limestones of Siesta formation, UCMP localities B-7266, B-7267, B-7268; and in the lower Mulholland beds, UCMP locality B-7269.

***Lymnaea filocosta* Hanna, 1923.**

Lymnaea filocosta HANNA, 1923, p. 38, pl. 2, fig. 5.

DIAGNOSIS. A small ovate species of *Lymnaea* with three and one-half convex whorls bearing very fine growth lines as only sculpture; columella straight, outer lip not expanded.

DISCUSSION. Although the present specimens are slightly crushed, they agree so closely with Hanna's original description that there is no doubt of their assignment to this species. Hanna relates *L. filocosta* to the Pliocene *L. alamosensis* from Santa Barbara.

OCCURRENCE. UCMP locality B-7268, Siesta formation. UCMP locality B-7270, upper Mulholland beds.

***Lymnaea* species compare *L. kerri* Hanna, 1923.**

Lymnaea kerri HANNA, 1923, pp. 38, 39, pl. 2, fig. 6.

DIAGNOSIS. A small high spired species of *Lymnaea* with four and one-half gently convex whorls bearing fine growth lines crossed by fine spiral striae.

DISCUSSION. Except for the absence of spiral striae, noted by Hanna in his original description, the present specimens are very similar to *L. kerri*. A further, though less important difference, is the greater size of the present

specimens, the altitude of one complete specimen being 1 cm., with a diameter of 4.0 mm., whereas Hanna gives an altitude of 4.2 mm. and a diameter of 2.3 mm.

OCCURRENCE. Upper Mulholland beds, UCMP locality B-7270.

PLANORBIDAE

Gyraulus Charpentier, 1837

Type *Planorbis albus* Müller (= *Planorbis hispidus* Draparnaud)
designated by Dall in 1870.

Gyraulus pabloanus (Cooper), 1894.

(Figures 2, 3.)

Planorbis pabloanus COOPER, 1894, pp. 54, 55, pl. 5, fig. 57.

DIAGNOSIS. A species of the planorbid gastropod *Gyraulus* with three and one-half very convex whorls bearing exceedingly fine growth striae as only sculpture; umbilicus $\frac{1}{2}$ diameter of shell.

DESCRIPTION. Shell discoidal, three and one-half very convex whorls; sculpture of fine, closely spaced axial growth lines, shell otherwise smooth; spire depressed; umbilicus funnel-shaped, wide, $\frac{1}{2}$ diameter of shell; aperture slightly elliptical, not descending; outer lip rounded, entire, not expanded; height of shell 1.3 to 1.6 mm.; diameter of shell 3.5 to 3.9 mm.

DISCUSSION. In his description of this species Cooper (1894, pp. 54, 55) states: "The absence of distinctive characters in most species of this genus, together with the flattening caused by pressure in the lignitic laminae, make it impossible to separate this from some other species, but more specimens may distinguish it better." While it is true that specimens from some places in the Siesta formation are deformed by pressure, enough relatively uncrushed specimens from other localities allow the following observations. When not crushed, the shell retains a marked convexity of its whorls, with no trace of peripheral angulation.

Since publication of Cooper's description more recent work in the taxonomy of planorbid mollusks has redefined and limited the concept of the genus *Planorbis*. As the genus *Planorbis* is presently defined (Baker, 1945) the species *P. pabloanus* should be removed from that genus and placed in the genus *Gyraulus*. The weakness of the axial striae, absence of subangular peripheries in the younger stages, fewer number of whorls, and lack of any expansion of the apertural lip precludes placing this species in the genus *Perrinilla*, as suggested by Hannibal (*in* Baker, 1945).

Although considerably smaller than Cooper's illustrated specimen, the available specimens exhibit a considerable size range and in my opinion should not be excluded from the species *Gyraulus pabloanus* on that highly variable criterion. This species, together with *Sphaerium cynodon*, form the dominant elements of the molluscan fauna of the Siesta formation.

OCCURRENCE. UCMP localities B-7266, B-7267, B-7268, Siesta formation. UCMP locality B-7269, lower Mulholland beds.

HELMINTHOGLYPTIDAE

Helminthoglypta Ancey, 1887

Type *Helix arbustorum* Linnaeus

Helminthoglypta species.

(Figure 4.)

DESCRIPTION. Shell small for genus, four and one-half to five whorls; embryonic whorls smooth, of one and one-quarter to one and one-half whorls; surface of shell somewhat papillose after embryonic whorls; sculpture of fine, simple, growth striae, becoming more prominent on latter whorls; distinctly umbilicate.

DISCUSSION. All specimens are rather badly crushed, so that original spire angle and height of spire are not observable. Found at only one locality, in the upper part of the Mulholland beds, where it is locally abundant.

OCCURRENCE. UCMP locality B-7270.

LIMACIDAE

Deroceras Rafinesque, 1820

Type *Deroceras gracilis* Rafinesque, 1820

Deroceras pachyostracon (Taylor), 1954.

Craterarion pachyostracon TAYLOR, 1954, p. 75, pl. 20, figs. 16-20.

DIAGNOSIS. "A very thick, convex subspiral, long-oval slug plate." (Taylor, 1954, p. 75).

DISCUSSION. Slug shells from the upper Mulholland beds are referable to *Craterarion pachyostracon* Taylor from the late Miocene Barstow formation, California. Taylor states (1954, p. 75) that *Craterarion* belongs in the family Arionidae and compares it with two recent genera of that family *Binneya* and *Hemphillia*. In this comparison, he lists three major differences between *Craterarion* and the Recent genera: 1, extreme thickness of *Craterarion*; 2, degree of coiling; 3, possession of a posterior process ("hook") in young specimens of *Craterarion*. He further states that *Craterarion* resembles some species of *Deroceras* in possessing a posterior "hook." I must add that it also approximates fossil species of *Deroceras* in 1, thickness; 2, posterior callus in adult specimens; 3, pattern and degree of coiling; 4, convexity of shell; and 5, plan of growth. After comparison with the fossil species *Deroceras aenigma* Leonard, I am convinced that *C. pachyostracon* is only specifically distinct from *D. aenigma*, and therefore belongs in the family Limacidae and not in the Arionidae. Living species of *Deroceras*, although having a similar growth pattern, are uniformly much thinner than the fossil species, which may represent an ancestral genus or subgenus. However, the shell in slugs of both families is a

vestigial structure, and as such is subject to considerable variation within a species. Therefore, to erect a new genus to accommodate the fossil species seems, in the absence of more complete data, to be unwarranted.

OCCURRENCE. UCMP locality B-7270, upper Mulholland beds.

PLEUROCERIDAE

Goniobasis Lea, 1862

Type *Melania olivula* Conrad, 1834

Goniobasis species.

(Figure 5.)

DESCRIPTION. Shell small, imperforate; spire high, number of whorls unknown, but more than six; whorls strongly convex, gradually enlarging; body whorl smoothly convex, with no concavity at base near columella; aperture about one-half the height of body whorl, entire, ovate, oblique; sculpture of regularly spaced axial cords, fine growth lines.

DISCUSSION. The size of the poorly preserved specimens is similar to that of *G. rodeoensis* (Clark), from Sonoma, and *G. leslieae* Firby, from the Esmeralda formation of Nevada. The sculpture, where preserved, suggests that they represent a distinct species.

OCCURRENCE. Two specimens from UCMP locality B-7268.

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